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The Acute Effects of Two Different Self-Myofascial Release Products on the Calf Muscle Pump and Plantar Flexion Ankle Range of Motion

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The Acute Effects of Two Different Self-Myofascial Release Products on the Calf Muscle Pump and Plantar Flexion Ankle Range of Motion

by

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The Acute Effects of Two Different Self-Myofascial Release Products on the Calf Muscle Pump and Plantar Flexion Ankle Range of Motion

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Background: Massage can promote healing and recovery following exercise. (Carefelli et al. 1992). Barnes (1990) proposed that myofascial release helps to break up fibrotic fascial adhesions that may restrict joint range of motion (ROM). Self-myofascial release (SMR) is a type of massage that uses a roller and an individuals body weight to produce massage like loading over a specific anatomical area. Viscoelastic properties of muscle tissue extensibility increase during an acute bout (15 minutes) of massage-like loading (Haas et al 2012). Self-massage on the calves reduced pain and edema of the calves on nurses after an 8.5-hour work shift (Oh and Yoon 2008). Increasing blood flow through skeletal muscle will lead to increased oxygen delivery, which can increase healing and return to homeostasis post-exercise. Different shapes and densities of SMR rollers may produce different outcomes (Johansson 1962, Curran et al. 2012). Hypothesis: TP Footballer will have a greater effect on popliteal artery blood flow volume *and* ankle ROM vs. the SPRI® foam roller. Methods: N = 21 subjects (10 male 11 female; 18-27). No current lower extremity injury (within one year). No exercise 48 hours prior to data collection. Exercise was defined as any rigorous physical activity lasting 30 minutes or longer. Subjects rested prone 20 minutes. Resting BF and AD measurements were taken with an 8-13 MHz probe via Sonosite Micromaxx Doppler Ultrasound. Ankle ROM

taken with a goniometer (mean of 3x). Statistics: Two-way repeated measure ANOVA and Bonferroni test was used to compare pre-test and post-test measures across both treatment conditions with two types of rollers. The α level was set at 0.05. Results: No significant increases found using the SPRI® foam roller on variables of BV, TAP and ROM in plantar flexion. Significant increases found with arterial diameter. Significant increases using the TP Therapy Products Footballer® on variables of: ROM in plantar flexion, BV, and AD Conclusion: SPRI® foam roller and TP Footballer® significantly increased popliteal arterial diameter. The TP Therapy Products Footballer® increased blood flow volume immediately following TP Therapy Soleus Protocol. TP Therapy Products Footballer® increased ankle plantar flexion immediately following TP Therapy Soleus Protocol.

Table of Contents

Table of Contents ..... **vi**
Chapter 1: *Introduction* **1**
Chapter 2: *Purpose* **4**
Chapter 3: Methods **5**
Participants 5
Study Design 5
Familiarization Session 6
SMR Products 7
SMR Protocol 7
Blood Flow Measurements 8
Plantar Flexion Ankle Range of Motion 9
Chapter 4: *Data Analysis* **11**
Chapter 5: *Statistical Analysis* **12**
Chapter 6: *Results* **13**
Chapter 7: *Discussion* **15**
Chapter 8: Conclusion **18**
References **19**

Chapter 1: *Introduction*

Massage can promote recovery and healing following exercise (Caferelli et al 1992, Callaghan 1993). One type of massage is myofascial release. Fascia is a connective tissue that surrounds muscles, nerves, blood vessels and connects bones to each other as well as muscle to bone and it helps to transmit forces between these structures (Barnes 1990). Myofascial is the fascia surrounding the muscles. Myofascial relase is massage loading technique that involves sustained pressure over a given area to eliminate pain and increase joint mobility (Barnes 1990).

Viscoelastic properties cause muscle tissue extensibility to increase during an acute bout (15 minutes) of massage-like loading (Haas et al 2012). Increases in ROM have been show in in both short and long-term training involving stretching (Drake et al 2011).

In individuals with low back pain, massage can increase ROM at the hip, decrease pain and decrease sciatic nerve pain symptoms (Bell 2008). Massage and compression of the lower leg can increase recovery in women with exercise-induced muscle damage (Jakeman et al 2010).

Massage can increase joint ROM while not changing maximal force production in the knee and hip joints (Hopper et al. 2005, Curran et. al 2008, Huang et al 2010, MacDonald et al 2012). Resting hamstring length was not affected after massage

(Barlow et. al 2004). One possible reason for a lack of statistical relevance in hamstring length is due to the small sample size that Barlow used. Thereapeutic modalities such as ultrasound and hot packs have been show to increase blood flow through the calf muscles (Baker et. al 1991).

Self-Myofascial Release (SMR) is one type of massage. During an SMR session an individual uses their body way on a roller to allow for “massage-like loading” of soft tissue on a particular area of the body. Common areas that are treated with SMR are the lower leg, upper leg and gluteal region.

Increasing blood flow through skeletal muscle will lead to increased oxygen delivery, which can increase healing and return to homeostasis post-exercise. Research concerning whether or not massage has an effect on blood flow through the musculature following massage has been mixed. One study found that following rigorous massage blood flow increased by 50% (Wakim et. al. 1949). SMR on the calves reduced pain and edema of the calves on nurses after an 8.5-hour work shift (Oh and Yoon 2008). Muscle temperature increases in the areas massaged which is indicative of an increase in blood flow (Sefton et al 2010). However, other studies have found that massage does not increase blood flow (Tiidus et al 1995, Shoemaker et al 1997, Hinds et al 2004).

The calf muscle-pump in critical for venous return from the leg to the heart. Contraction of the triceps surae muscles facilitates this mechanism to prevent venous pooling in the deep veins which can lead to things such as edema and deep venous thrombosis (Stick et al 1989).

It is reasonable to conclude that roller shape, density and design may play in critical role on the effectiveness of the function of the calf muscle pump (Curran et. al 2012). There is no research that examines the effects of SMR on the calf muscle pump as it relates to popliteal artery blood flow volume, arterial diameter and peak to peak blood flow values.

Chapter 2: *Purpose*

The purpose of this study is to compare how two different SMR products with different shapes and different densities affect blood flow plantar flexion ankle ROM using the same target force and protocol. The results of this study will show how effective each product is relative to blood flow measurements and ankle ROM.

Chapter 3: Methods

PARTICIPANTS

21 participants consisting of 10 men (22.80 ±3.22 years, 171.05 ± 16.91 lbs, 70.15 ±1.75 inches) and 11 women (21.64 ±2.58 years, 141.45 ± 25.92 lbs, 66.39 ±3.97 inches) were recruited from a university population for this study. All participants had no history of lower extremity injury or any history of a neurological disease. All participants provided written and informed consent. The Internal Review Board at the University of Texas-Austin approved this study.

STUDY DESIGN

A pre/post-test design was used for this study. The effect of rolling the calf muscles on blood flow and ankle range of motion (ROM) with an SPRI® foam roller versus Trigger Point Therapy Products Footballer™ Measures included ankle ROM, arterial diameter, mean blood flow volume (BV) and peak to peak (time average peak (TAP)) blood flow measurements. Participants were required to abstain from exercise 48 hours before the study sessions. A familiarization session was required followed by two randomized sessions.

Each session lasted approximately one hour. Participants were instructed to arrive and rest for 20 minutes in a prone position with their ankles elevated to allow for ankle comfort that may be caused due to limited plantar flexion. After resting, blood flow measurements were taken with a Sonosite M-Turbo 2012

Doppler Ultrasound and a 8-13 MHz HFL38x linear transducer at the posterior knee on the right leg.

These measurements included arterial diameter (AD), blood flow volume (BV), and time average peak (TAP). Following popliteal blood flow measurements, the subject rolled over to a seated position.

The investigator held the right foot the entire time and placed the leg on the SMR product at the distal portion of the muscle belly from a neutral ankle position. The SMR product was placed over a force plate and a “target force” measurement taken from the familiarization session was marked with tape and a black marker. The subject was instructed to maintain the same amount of force on both products during the SMR protocol. Immediately following the SMR protocol the subject was rolled over into the initial prone position with the ankle support. Both blood flow measurements and ankle ROM measurements were retaken. After measurements were taken the session was over and then seven days later at approximately the same time the second session was administered.

FAMILIARIZATION SESSION

During the familiarization session the subject filled out an informed consent form and a Physical Activity Readiness Questionnaire (PAR-Q) form. Height and weight measurements were taken to calculate subject BMI. The subject then was taken through the SMR protocol via DVD from Trigger Point Therapy Products. This protocol was used on both SMR products. After viewing the DVD the

protocol was then sat in place for the SMR protocol with their leg propped on the Trigger Point Therapy Footballer®. This product was on a 4” x 4” x 6” foam block on a force plate.

The subject’s leg was placed on the footballer in the appropriate testing position and asked to place the left leg on top to add pressure. The force was recorded using a force plate (Bertec Force Plate) and an oscilloscope (Tektronix, Inc.) was used to mark the participants “target force.” This data was recorded and used as the force the subject would try to maintain throughout the SMR protocol. Force was considered too great if the subject tried to hold their breath or could not go through the appropriate range of motion due to pain. After the target force was selected and the protocol had been thoroughly practiced to the participants understanding the session was over.

SMR PRODUCTS

Two different SMR products were used in this study. One of the products was a SPRI® 12” x 6” foam roller (FR). The other product was a Trigger Point Therapy Products Footballer® (FB).

SMR PROTOCOL

Participants had their right leg placed on the randomized selected SMR product. The position was selected based on where the calf muscle belly meets the musculo-tendonous junction at a neutral ankle position. The left leg was then place on top of the right in a resting position. From this position the subject was

instructed to watch the oscilloscope and try and keep the force measurement line in place with the preselected target force mark throughout the entire protocol. The subject was then instructed to “slightly bend and extend” their legs three times keeping the force constant on the middle of the muscle belly. After the third time the subject was told to keep the right leg in an static extended position and circle the foot and ankle complex two times in a clockwise direction and then two times in a counter clockwise direction.

The participants then repeated this process with the leg in a slightly medially rotated position and then again in a slightly laterally rotated position.

BLOOD FLOW MEASUREMENTS

Blood flow measurements were taken with a Sonosite M-Turbo Ultrasound (2012 model with a probe (2010 model that was T08189) 8-13 MHz Study participants were instructed to rest for 20 minutes in a prone position with their ankles propped over a roller to facilitate ankle comfort. While participants were resting the examiner used the ultrasound to locate the popliteal artery. Once the popliteal artery was located the examiner located a bifurcation point to and took measurements just inferior to the bifurcation.

The examiner traced the outside of the probe with a permanent marker to facilitate taking fast measurements after the protocol was performed. The position of the probe, as well as the depth and gate of the ultrasound band will be

adjusted for each subject at the beginning of the experiment to maximize the Doppler signal from the popliteal artery.

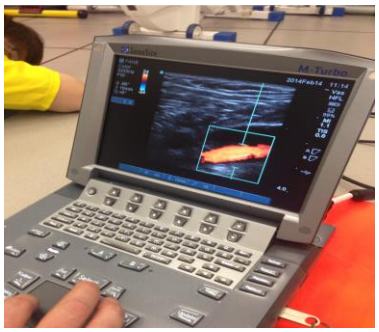

Figure 1

Mean blood velocity (MBV) is indicative of blood flow (BF), only if the arterial diameter (AD) is constant. BF = MBV x πr^2 where r is the radius. To determine arterial diameter, we will image the posterior popliteal artery. The isonation angle of the measurement was set at 60 degrees and AD, time average peak (TAP) measurements were taken measuring peak to peak velocity.

The investigator to this study was thoroughly trained by a trained sonographer with over 15 years of experience with blood flow measurements. In addition, the investigator performed a reliability study to ensure ultrasound measurements were accurate.

PLANTAR FLEXION ANKLE RANGE OF MOTION

Ankle range of motion was measured with a goniometer (360 degree ISOM–12”). The goniometer axis of rotation was placed on the right leg lateral malleolus and the vertical rod aligned with the tibia while the horizontal rod aligned with the 5th

metatarsal. The subject was asked to, “point your toe as much as you can” three times. The mean value of these three trials was given as their maximal plantar flexion score.

Chapter 4: *Data Analysis*

All data will be stored on a password protected computer and backed up on password protected electronic storage devices. Data was manually entered into a Microsoft Excel spreadsheet in addition to being stored other relevant devices (M-Turbo Ultrasound). Target force was not recorded. To ensure accuracy of the investigator during this study sensitivity analysis was utilized for BV, AD, TAP and ankle ROM measures. All flash drives containing files will be coded so that no personally identifying information will be visible on them. All discs will be kept in a secure place in Belmont 546G. These flash drives will be assessed only for research purposes by the investigators and their colleagues and will be retained for future analysis. The only individuals who will have access to the password protected computer were the investigators of this study. Data was manually entered into a Microsoft excel spreadsheet and stored on a password protected computer.

Chapter 5: *Statistical Analysis*

A two-way repeated measures anova was used to analyze the data comparing pre and post measures of BF, TAP, AD and ankle ROM using the Footballer® and SPRI® foam roller. The significance value of $P < .05$ was set a priori. Data was then analyzed using SPSS software.

Chapter 6: *Results*

There were four outcome variables: AD, BV, TAP and ankle ROM. The two factors were the following: time (pre and post massage treatment), type of roller (FB and FR).

There was a significant interaction for AD between treatment and types of roller (p=0.029). A significant increase in AD after massage treatment was found following use of the FB (p<0.025) while no differences were observed with the FR.

For TAP, there was a significant main effect of treatment (p=0.002). A significant increase in TAP after treatment (p=0.002) was found in both types of SMR products.

There was a significant interaction between treatment and types of roller for BV (p=0.039). A significant increase in BV after treatment was found in FB group (p<0.025) while no differences were observed in FR group.

For ankle ROM, there was a significant interaction between treatment and types of roller (p=0.000). A significant increase in ankle ROM after treatment was found in FB group (p<0.025) while no differences were observed in FR group.

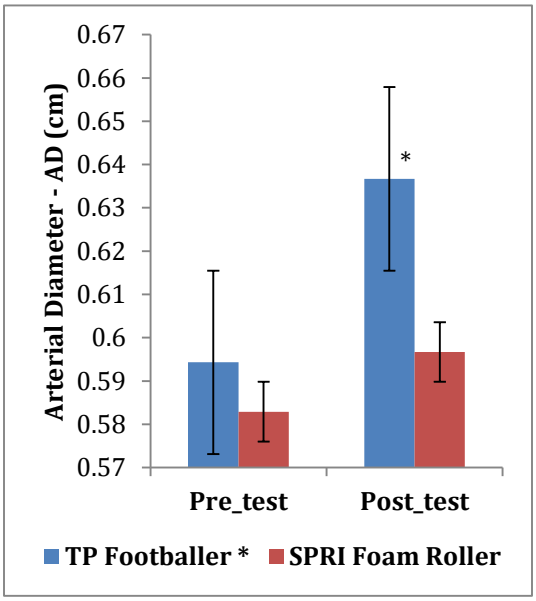

Figure 2

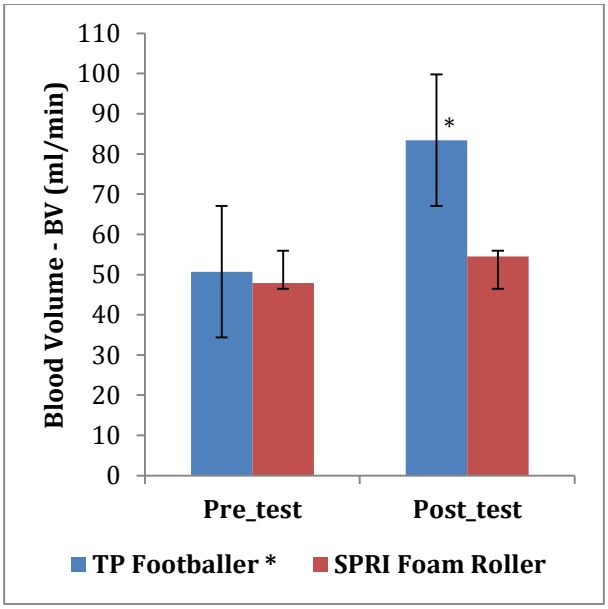

Figure 3

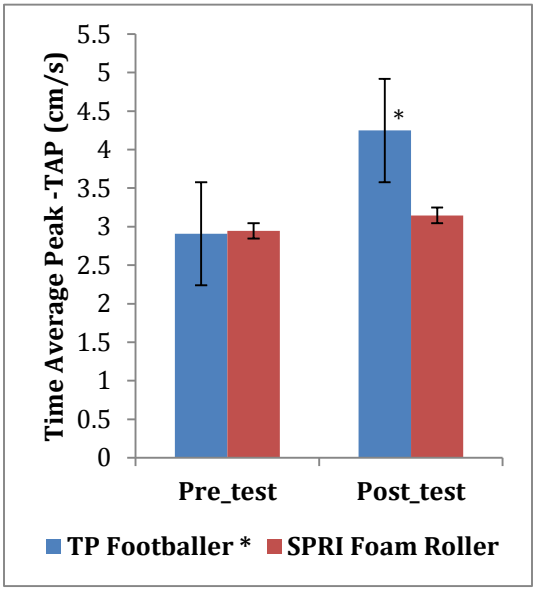

Figure 4

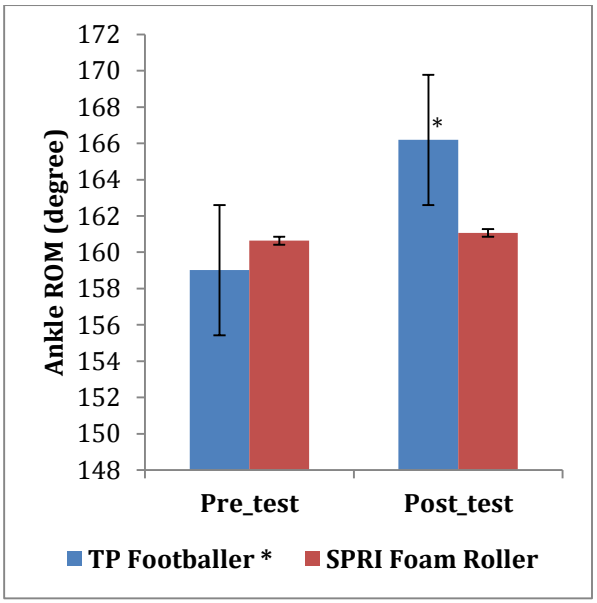

Figure 5

- **shows statistical significance at the .05 level**

Chapter 7: *Discussion*

The results demonstrate that in a healthy population, the FR (Trigger Point Therapy Products Footballer®) stimulates more blood flow through the popliteal artery and increases plantar flexion range of motion than the FR (SPRI® Foam Roller). These findings suggest that given the same protocol and target force, a product that provides a firmer more acute pressure on the calf muscles will increase these parameters. It is possible that the increase in plantar flexion ROM was due to muscular excitability (Sullivan et al 1991).

A possible explanation for both the increased ankle ROM and blood flow volume is the thixotropic properties of muscle fascia (Nordez et. al 2008). One study showed that there was no increase in knee extension ROM after SMR was applied to the hamstrings. However, it should be noted that muscles such as the gastrocnemius and popliteus could be limiting factors regarding knee extension and the hamstrings. Both the popliteus and the gastrocnemius can flex the knee.

SMR studies are rapidly increasing in literature as a viable way to treat injury and promote joint range of motion (Sullivan et al 2013, Healey et al 2014). While there has been much “hearsay” about the effectiveness of SMR modalities among clinicians research on SMR is still in its infancy.

To our knowledge this is the only study that has compared two different types of SMR products with regards to blood flow through the popliteal artery. The purpose of this study was to examine the effects of two different SMR products

that were different in shape and size while attempting to keep all other variables constant. We hypothesized that the FB would be more effective on increasing BV, AD, TAP and ankle ROM than FB.

While this study was simple in design, it was well controlled and we believe that knowledge has been gained as a result and can add some confirmation on certain arguments for utilizing different products for this.

It must be noted that this study examined acute effects. It would be interesting to perform the same kind of study but measure the same variables after five, ten and one hour. We found that the FB was more effective in stimulated popliteal artery blood flow than the FR. The pressure exerted on muscle via massage stimulates local blood flow (Mori et al 2004). In addition, SMR was more effective in eliciting a greater range of motion after performing the protocol. One explanation for this is the possibility of the increase in temperature reducing fluid viscosity within the muscle tissue (Drust et. al 2003). Massage loading has been shown to increase range of motion (Hopper et. al 2005)

This study had limitations. While the order was randomized as to which SMR product would be used, the investigator was not blinded to product used. In addition this study was an acute study. More studies need to be done on the long-term effects of utilizing SMR products like these. While this study used a target force for all of it's participants, the actual force values themselves were not recorded. Another limitation that would have been good to have in this study would be to have a "perceived level of comfort" (Borgs pain scale) for each

product. Participants were encouraged to medially and laterally rotate their femur to position the middle, lateral and medial parts of the calf muscles, however hip range of motion was not measured in this study.

Chapter 8: Conclusion

SMR is commonly used to increase blood flow and increase joint range of motion. This study demonstrates that both density and shape of the product has a direct influence it's effectiveness as it relates to acute ankle ROM and blood flow measurements through the muscle pump the calf and ankle. The more firm and acute the pressure, the more effective it was in this study. This makes sense given that acute compression over a smaller area stimulates more local blood flow.

More studies need to be done around the duration that this effectiveness lasts. In addition one limitation of this study is that the investigators did not account for perceived pain levels. One would assume that dorsiflexion would increase given the argument for tissue extensibility. The dorsal muscles were not examined or compressed during this experiment yet plantar flexion range of motion increased. The mechanism for this is unclear.

Possible clinical relevance included but is not limited to stimulating blood flow through the lower extremity prior to warming up for an athletic event or activity. It might also suggest that it would be beneficial after the calf muscle pump has been compromised for a long period of time (seated on a long plane ride).

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